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Update of Sentinel Survey Results in NAFO Divisions 2J3KL for 1995-2012

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Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

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ABSTRACT

Data from the Sentinel program in the Northwest Atlantic Fisheries Organization's (NAFO) Divisions (Div.) 2J3KL are presented for 1995 to 2012. Mean gillnet (5½") catch rates of Atlantic Cod (number per net) in Div. 3K and 3L were relatively high in 1996 and 1997, increased to the highest value in 1998 and then decreased to 2003. Since then, catch rates increased to 2008, declined to 2009 and 2011 in Div. 3K and 3L, respectively, and increased again in 2012 to reach the second highest value in the series for 3L and the highest for 3K. In Div. 2J, although catch rates in 5½" gillnet were very low in all years, they show a marked increase in 2005 and remain at similar levels through 2011. In 2012, gillnet catch rates in Div. 2J almost tripled. Small mesh gillnet catch rates have been more variable and trends are more difficult to discern, probably linked to this gear catching fish from two distinct size ranges. Linetrawl catch rates (number of fish per 1000 hooks) in Div. 3K and 3L showed similar trends to 5½" gillnet, decreasing from the late 1990s to the early 2000s. In Div. 3L, there has been a general declined in linetrawl catch rates, while in Div. 3K mean catch rates increased from 2000 to 2009 and has since generally declined. There has been no linetrawl activity in Div. 2J since 2001.

Catch rates of Atlantic Cod were generally higher in the Central Inshore area (NAFO unit areas 3Kh, 3Ki, 3La and 3Lb) compared to the Northern Inshore (2Jm, 3Ka and 3Kd) and Southern Inshore areas (3Lf, 3Lj and 3Lq). In recent years, catch rates have improved considerably in the Northern Inshore area and in 2012, the catch rate in 5½" gillnet was the highest in the time series. For each unit area in the Central Inshore area, the 2012 5½" gillnet catch rate was higher than the series mean and also improved from 2011. In the Southern Inshore area recent years' catch rates were below the time series mean in both 3Lj and 3Lq, but above the time series mean in 3Lfwhere, the 2012 catch rates were the second highest in the series. In the small mesh gillnet, trends in catch rates were similar to those in the 5½" gillnets, with higher catches in the central area. In the Northern area, catch rates were above the series mean in 2012, while they were either at or above the series mean in the Central Inshore area. In the Southern Inshore area, catch rates during the most recent years were below the time series means. Linetrawl was not used extensively in Div. 2J3KL, however, catch rates were lower in most unit areas in recent years.

Trends in liver and gutted body condition of cod showed a seasonal cycle, with condition declining over the winter and early spring, and increasing again over the summer once spawning has occurred. Annually, condition was variable but stable from 1995 to about 2005, showed a decline to 2009 in females, and 2010 in males before increasing once more for both sexes to 2012.

Derniers résultats des relevés des pêches sentinelles dans les divisions 2J3KL de l'OPANO : 1995-2012

RÉSUMÉ

Les données du programme sentinelle des divisions 2J3KL de l'Organisation des pêches de l'Atlantique Nord-Ouest (OPANO) qui sont présentées couvrent les années 1995 à 2012. Les taux de prise moyens de morue franche (nombre par filet) à l'aide d'un filet maillant de 90 cm (5 ½ po) dans les divisions 3K et 3L étaient relativement élevés en 1996 et en 1997. Ils ont atteint la valeur la plus élevée en 1998, puis ont diminué jusqu'en 2003. Depuis, les taux de prise ont augmenté jusqu'en 2008, puis ont baissé entre 2009 et 2011 dans les divisions 3K et 3L, respectivement. Ils ont augmenté de nouveau en 2012, atteignant la deuxième valeur la plus élevée de la série pour la division 3L et la valeur la plus élevée pour la division 3K. Dans la division 2J, malgré le fait que les taux de prise au moyen du filet maillant de 90 cm (5 ½ po) étaient très faibles pour toutes les années, il y a tout de même eu une augmentation considérable en 2005 et les taux sont demeurés à des niveaux semblables pendant 2011. En 2012, les taux de prise au moyen du filet maillant de la division 2J ont presque triplé. Les taux de prises au moyen de petits filets maillants ont varié davantage et il est plus difficile de repérer les tendances, sans doute parce que ces filets permettent de capturer des poissons de deux tailles différentes. Dans les divisions 3K et 3L, les taux de prises à la pêche à la palangre (nombre de poissons par tranche de 1 000 hameçons) affichaient des tendances semblables à celles des taux de prises au moyen de filets maillants de 90 cm (5 ½ po), diminuant à partir de la fin des années 1990 jusqu'au début des années 2000. Dans la division 3L, il y a eu un déclin général dans les taux de prise à la palangre, tandis que dans la division 3K, les taux de prise moyens ont augmenté de 2000 à 2009 et ont depuis diminué de manière générale. Il n'y a pas eu d'activité de pêche à la palangre depuis 2001 dans la division 2J.

Les taux de prise de morue franche étaient généralement plus élevés dans la zone côtière du centre (sous-divisions 3Kh, 3Ki, 3La et 3Lb de l'OPANO) que dans la zone côtière nordique (sous-divisions 2Jm, 3Ka et 3Kd) et la zone côtière du sud (sous-divisions 3Lf, 3Lj et 3Lq). Au cours des dernières années, les taux de prise se sont considérablement améliorés dans la zone côtière nordique et en 2012, le taux de prise au moyen d'un filet maillant de 90 cm (5 ½ po) était le taux le plus élevé de la série chronologique. Dans chaque sous-division de la zone côtière du centre, le taux de prise pour 2012 au moyen du filet maillant de 90 cm (5 ½ po) était plus élevé que la moyenne de la série chronologique et s'est amélioré par rapport à 2011. Les taux de prise des dernières années des sous-divisions 3Lj et 3Lq de la zone côtière du sud ont été inférieurs à la moyenne de la série chronologique, mais ceux dans la sous-division 3Lf ont été supérieurs à la moyenne de la série chronologique (les taux de prise de 2012 étaient les deuxièmes en importance de la série). En ce qui concerne les petits filets maillants, les tendances en matière de taux de prise étaient semblables à ceux des filets maillants de 90 cm (5 ½ po), des taux de prise plus élevés ayant été enregistrés dans la zone du centre. Dans la zone nordique, les taux de prise étaient supérieurs à la moyenne en 2012, tandis que dans la zone côtière du centre ils étaient égaux ou supérieurs à la moyenne de la série. Dans la zone côtière du sud, les taux de prise au cours des dernières années étaient inférieurs à la moyenne de la série chronologique. La pêche à la palangre n'a pas été beaucoup pratiquée dans la division 2J3KL. Cependant, les taux de prise étaient plus bas dans la plupart des sous-divisions au cours des dernières années.

Les tendances en ce qui a trait à l'état du foie et au poids après éviscération de la morue montrent un cycle saisonnier, l'état s'affaiblissant au cours de l'hiver et au début du printemps, et s'améliorant à nouveau pendant l'été, une fois la période de fraie terminée. Annuellement, l'état était variable, mais stable de 1995 à environ 2005, et a présenté un déclin jusqu'en 2009 chez les femelles et jusqu'en 2010 chez les mâles avant d'augmenter encore une fois chez les deux sexes jusqu'en 2012.

INTRODUCTION

Sentinel survey projects were formally announced by the Minister of Fisheries and Oceans Canada (DFO) in October, 1994. The surveys in the DFO Newfoundland and Labrador Region are an extension of the index fishermen's project from the Northern Cod Science Project Program with modifications to allow for science activities achievable only under a fishing moratorium. Sentinel data collection continued during the commercial/index fisheries that occurred from 1998 to 2002 and in the stewardship fisheries during 2006-12.

The sentinel survey has the following objectives:

1. To develop a catch rate series for use in resource assessments;
2. To incorporate the knowledge of inshore fish harvesters in the resource assessment process;
3. To describe the temporal-spatial distribution of cod in the inshore area over a number of years through, for example, the use of catch rate information, tagging studies, by-catch information and fish harvester's observations;
4. To gather length frequencies, sex and maturity data and sample ages for use in resource assessment;
5. To establish a long-term physical oceanographic and environmental monitoring program of the inshore areas; and
6. To provide a source of biological material for other researchers. For example, tissue for genetic, physiological and toxicological analyses, cod stomachs for food and feeding studies and by-catch information.

PARTICIPANTS

The primary collectors of data in the sentinel survey are inshore fisher harvesters. Through consultation with inshore fish harvesters and fisheries organizations, traditional inshore fishing grounds have been identified and mapped.

Fish harvesters from communities within the boundaries of the identified coastal areas and who met eligibility criteria were invited to apply to participate in the survey. Where more than one application was received from an area, the project partner conducted a draw or lottery to select the participant. While there was considerable interest in the project in most areas, there were many sites from which only one application was received and others where additional canvassing was required to enlist participants. At the beginning of the project, selected participants were required to complete a six-week course designed by the Marine Institute of Memorial University in consultation with DFO. Topics covered included scientific sampling methods and equipment, computer use, resource assessment basics and presentation skills. When enterprises required training in years subsequent to the original project setup, training consisted of on the water training by personnel from DFO and the project partner.

In order to minimize inter annual enterprise effects on data collection, participants are expected to remain with the survey over a number of years. It is also expected that most of the sampling activities will continue once commercial fishing operations resume and the sentinel participants will form a core of index fish harvesters.

SITES

In the early part of the time series, about 60 inshore fishing enterprises representing communities from Black Tickle to St. Mary's Bay participated in the Div. 2J3KL Sentinel Survey. A reduction in the survey coverage resulting from funding pressure was implemented in 2005, and since then there have been 40-45 enterprises participating. Survey activity covered mostly summer and fall periods in all years, traditional fishing times for the areas involved. The specific location of each site was chosen at the start of the time series, after consultation between DFO scientists, fish harvesters, the Fish, Food and Allied Workers Union (FFAW) and the Fogo Island and Petty Harbour Co-operatives (for Fogo Island and Petty Harbour). Site selection was based on the need to survey throughout inshore areas and targeted historical fishing areas and historical gear use patterns.

SAMPLING STRATEGY

Table 1 gives the homeport of the participants in the sentinel surveys, shows the number of sets completed in each year, and the number of fishing enterprises participating in the survey. The timing of sampling was determined after discussions with harvesters but was targeted for seasonally appropriate times based on historical fishing patterns. In 2012, there were 40 fishing enterprises participating in the sentinel survey in Div. 2J3KL.

Gillnets and linetrawl were used to survey inshore areas in Div. 2J3KL. Cod traps were used from 1998 to 2002 to varying degrees to sample fish, but are no longer used in the Sentinel Survey. Hand lines were used mostly in conjunction with nets or trawls as a means of determining presence of cod for tagging purposes or when nets were not catching fish. Petty Harbour survey participants used hand lines exclusively in the Sentinel Survey. This gear was used mainly for biological sampling as catch rate information from hand lining is difficult to interpret.

Hook and line crews fished two tubs of baited linetrawl. Each tub consisted of approximately 500 hooks for a total of 1000 hooks per fishing day. Gillnet crews fished a maximum of six 50 fathom 5½" monofilament gillnets. Nets were rigged two-to-three to a fleet and up to three fleets were fished per fishing day. In addition, selected sites fished one 3¼" monofilament gillnet at least one day per week. All fish caught in gillnets and on hooks were landed and measured. If catches exceeded 500 kg per week, the numbers of nets in a fleet were cut back. However, some consideration was given to bottom topography and net performance when reducing the number of nets in a fleet. Similarly, the number of hooks per tub was reduced if landings exceeded 500 kg per week. Other measures were considered if fish are particularly abundant in an area and catches appear to be excessive even with the minimal amounts of gear possible.

Prior to the start of sampling in 1995, a fixed (control) location on the fishing grounds was established for each site and will remain fixed for the duration of the project. Each fishing day, up to half of the gear was set at the control site. The remainder of the gear (experimental) was set at one or two other locations on the fishing grounds at the discretion of the crew. The location of each fishing set, and the time of the set and the soak time for the gear were recorded. Other environmental observations were noted, including wind direction and speed, percent cloud cover, tide conditions, presence of invertebrates (bait) and other fish species in the area, marine mammals, sea birds and any other variables which might have influenced fishing behavior.

Selected sites were equipped with a Conductivity-Temperature Device (CTD) (measuring temperature and salinity at depth) in several years. At these locations, casts were conducted in the vicinity of fishing sets each fishing day. Conductivity-Temperature Device locations were fished for subsequent years when possible.

Catches from control and experimental gear were measured for length and sex. Otoliths were sampled on a fish length-stratified basis. Selected participants collected a length-stratified sample of up to 100 frozen fish on a biweekly basis for detailed biological sampling. Weight analysis measurements were taken on these samples and condition indices were calculated using:

- Fulton's condition factor (Ks)=gutted weight (g) x length (cm)-3 x 100
- Hepatosomatic Index (HSI)=liver weight (g) x gutted weight (g)-1 x 100
- Gonadosomatic Index (GSI)=gonad weight (g) x gutted weight (g)-1 x 100

Other biological samples were collected when requested. Since 2005, species other than cod have been recorded and measured as well, and this by-catch information is presented as number of fish caught per day (control and experimental sets combined).

For assessment purposes, the inshore area was subdivided into three inshore areas in the 2005 assessment. The Northern Inshore area included NAFO unit areas 2Jm, 3Ka and 3Kd, the Central Inshore area included 3Kh, 3Ki, 3La and 3Lb, and the Southern Inshore area included 3Lf, 3Lj and 3Lq. Some plots summarizing Sentinel data by these groupings are given for comparison to standardized indices that use these three inshore areas.

RESULTS

Figures 1-3 show the catch rates of Cod (in scaled symbols) from every set in 2011 and 2012 of 5½" gillnet, 3¼" gillnet, and linetrawl. Control sites were generally consistent from year to year but shifts in location may have resulted due to weather or tide conditions or competition for sites by commercial activity.

Figures 4-6 summarize Sentinel activity by gear type and NAFO Division from 1995 to 2012 and give the number of sets of gear in each division (Nhauls), the total number of Cod caught (Nmeas) and the number of sets that had no Cod in them (Nzero). 5½" gillnet is the major survey gear in Div. 2J3KL and in 2012 there were about 2200 sets completed and 92000 fish measured (Fig. 4). Effort was greater in 2000 to 2002 with about 3100 sets, although the number of fish measured was much lower in those years. Small mesh gillnet (3¼") was used to a lesser extent, to give information on smaller fish. Effort with this gear has declined from the early 2000s when about 400 sets were completed to 300 sets in 2011 (Fig. 5). In 2012, almost 11000 fish were measured from 359 sets. Linetrawl effort declined from 1995 (830 sets) to 2000 (143 sets) and in recent years is much lower at 80 to 140 sets. Since 2000 the number of Cod measured in this gear have ranged from 2400 to 6700 (Fig. 6).

Figures 7-9 plot the average Catch per Unit of Effort (CPUE) for each enterprise (listed by community) for the three gear types used in sentinel activity, showing the mean of the time series ± 1 standard deviation, as well as the mean for 2011 and 2012. Figures 10-12 give mean catch rate by NAFO unit area compared to the time series mean (1995-2012). In general, the series mean catch rates in 5½" gillnet (Fig. 7) were very low in northern areas, increased toward the central inshore area (particularly in Bonavista and Little Catalina areas) and were lower in Conception Bay and on the southern shore (the Southern Inshore area). Catch rates in 2012 were higher than the series means in many locations in the Northern Inshore and Central Inshore areas. The increase in 2012 was most prominent in NAFO unit areas 3Kd and 3Kh (Fig. 10). In many areas, catch rates were higher than the time series mean in the last several years. Small mesh gillnet (Fig. 8) showed more spatial and temporal variability in CPUE with high catch rates in 2J and 3K in some years. 2012 catch rates in this gear did not increase like those in 5½" gillnets. Catch rates in small mesh gear were most consistent from Wesleyville to

Petley. Linetrawl was not as widely employed as gillnet in the Sentinel survey on Div. 2J3KL and catch rates were variable in recent years, with some sites having higher than average catches, while others were lower.

When grouped by NAFO unit area, highest catch rates were in unit area 3La (Fig. 11). Linetrawl is not used extensively in Div. 2J3KL (only 7 sites use this gear) and catch rates are more variable between sites and from year to year. The highest linetrawl catch rates have generally been in the Central Inshore area (Fig. 9) and when grouped by unit area, have been lower in recent years in most areas, although catch rates remain near the time series mean in unit area 3Kd.

Average annual catch rates of cod are shown by NAFO Division for each gear type in Fig. 13. Trends in 5½" gillnet are similar in Div. 3K and 3L, declining from 1998 to 2002 and then increasing to 2008 (Fig. 13 top panel). Then, catch rates declined before increasing once more in 2012. The 2012 value was the highest in the time series for Div. 3K, and was second highest in the series for 3L. Catch rates were much lower in Div. 2J and from 1995 to 2004 catch rates were near one fish per net or lower. From 2000 to 2011 CPUE ranged from two to four fish per net. In 2012, catch rates in Div. 2J increased to nearly eight fish per net. Trends in small mesh gillnet (Fig. 13 middle panel) are unclear, and have varied around 40 fish per net in Div. 3K and 3L. Division 2J had lower catches in this gear, although were still about 20 fish per net in most years. Linetrawl (Fig. 13 lower panel) showed an overall decline in Div. 3L since 1997 while catch rates decreased from 1997 to 2000 in Div. 3K and then increased to 2009. Catch rates then declined once more to 2011 and were slightly higher in 2012.

Annual length frequencies of Cod are shown in Figs. 14-16 as proportion at length by gear type for each NAFO division. The 5½" gillnet frequencies (Fig. 14) show the narrowest range of size selectivity (catching mostly fish 55-75 cm). Given the highly selective nature of this gear, frequencies are generally the same shape from year to year, although in Div. 3K, the frequency seems to show a shift toward larger fish in 1997 and again in 2009. In Div. 2J, during the early years of the survey few fish were caught in the 5½" gillnets which resulted in the size frequency curve appearing jagged compared to the curves from Div. 3K and 3L. Interestingly, with fewer fish in the frequency, there seems to be a bimodal shape to the curve similar to that seen in the small mesh gillnet. When the catch of larger fish increased in recent years, the fish evident at smaller sizes is less noticeable. The size frequencies in Div. 3K and 3L are wider in recent years, as the gear caught a greater range of fish sizes.

Small mesh gillnets catch primarily smaller fish (in the 35-45 cm range) but a second mode of fish is also evident in the 50-65 cm range (Fig. 15). Changes in size distribution are difficult to detect in this gear (similar to the 5½" gillnet) due to its limited selection pattern, But in recent years, there was an increase in catch of larger fish (the 50-65 cm mode) compared to the years when the second mode mostly disappeared (1999-2002).

Linetrawl has the widest range of size selection (Fig. 16) among the gears used in the Sentinel survey, catching Cod from about 30 to 70 cm. Changes in size distribution of fish can be detected in this gear more readily than in gillnets and in Div. 3K and 3L a shift toward larger fish is evident from 2002 to 2007, followed by a more extended range of sizes being represented in the catch from 2008 to 2012.

Data on body condition (Ks), liver condition (HSI), gonad condition (GSI), length and weight at age for cod were compiled for monthly and annual trends (Fig. 17). Liver and gutted body condition cycled seasonally, as did the gonadosomatic index (GSI) for both males and females. GSI increased from February to June in females, as the ovaries enlarged in preparation for spawning, and decreased over the spawning season (April to September) to a low value in the fall. Both liver and body condition were lowest in April/May and were highest from August to

December. Annually, condition (Ks) was generally stable from 1995 to about 2005, and then declined to 2009 in females and 2010 in males. Condition then increased to 2012.

By-catch information was collected as total number of fish (other than cod) caught in sentinel gear for each year and is given in Fig. 19 for 2005-12. The majority of the Sentinel survey in NAFO Div. 2J3KL is conducted by gillnet, and the by-catch information is dominated by catch in this gear. Winter Flounder, American plaice, Yellowtail Flounder, Greenland Halibut and Redfish were the main by-catch species, For Winter Flounder, by-catch has been variable, and in 2012 was the highest in the time period. American Plaice by-catch has declined since 2008, and for Greenland Halibut (turbot) by-catch was higher in 2008-10 than in the following years. No trend is evident in Redfish by-catch and other species were caught at low levels in Sentinel gear.

DISCUSSION

This document summarizes the catch rate trends and length frequency data for sentinel surveys in NAFO Div. 2J3KL from 1995 to 2012. Given the large spatial coverage of the survey and the differences in timing of the survey between locations, relating observations on catch rate to changes in population dynamics of Atlantic Cod requires standardizing the data for time and location effects. These analyses were undertaken and reported in Brattey et. al. (in press), and in the Science Advisory Report for Northern Cod (DFO 2012). In general, trends in the unstandardized data were in agreement with results from the analyses that took time and location into account.

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TABLES

Table 1. Number of Sentinel sets (5½" gillnet) by community since 1995.

NAFO DIV. 2J

Community	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Black Tickle	-	48	46	40	48	42	57	54	54	60	60	52	60	59	60	58
Williams Hr	54	46	44	40	30	40	42	36	-	38	-	-	-	-	-	-
Tub Hr	22	10	12	12	27	60	56	60	-	-	-	-	-	-	-	-
Triangle	22	17	20	22	47	60	56	56	58	60	60	60	60	60	60	56
Penny's Hr	45	49	39	46	48	61	56	42	60	59	54	59	60	59	60	59
Spear Hr	47	68	67	71	48	59	59	66	60	60	60	60	60	59	-	-
St. Lewis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60	58
St. Lewis	-	71	69	39	46	59	60	59	60	60	60	60	60	59	60	60
Mary's Hr	-	-	-	-	-	57	59	60	58	58	60	54	60	60	59	60
Cape Charles	28	24	22	24	47	-	-	-	-	-	-	-	-	-	-	-

NAFO DIV. 3K

Community	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Quirpon	-	-	-	-	-	-	60	-	-	-	-	-	-	-	-	-
St. Lunaire	38	51	43	46	60	60	60	60	56	60	60	60	60	-	-	-
St. Lunaire	-	-	-	-	-	-	-	-	-	-	-	-	-	58	60	60
Great Brehat	54	68	58	70	30	-	-	-	-	-	-	-	-	-	-	-
Goose Cove	-	21	48	56	46	46	52	54	60	61	60	59	50	50	48	50
Conche	39	42	45	48	60	60	60	58	60	60	60	60	60	60	60	60
Englee	40	42	43	48	48	60	61	60	60	60	60	-	-	-	-	-
Englee	-	-	-	-	-	-	-	-	-	-	-	51	60	54	59	-
Hr Deep	36	44	34	42	46	56	54	54	60	59	57	59	58	58	57	60
Jackson's Arm	44	54	49	72	45	-	-	-	-	-	-	-	-	-	-	-
Sopp's Arm	-	-	-	-	-	50	59	60	60	57	59	60	38	57	60	60
Westport	-	-	-	-	-	58	60	55	-	-	-	-	-	-	-	-
Coachman's Cove	20	23	38	40	49	56	55	55	56	57	59	51	56	56	56	56

Community	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Ming's Bight	-	-	-	17	32	34	30	36	29	36	36	42	41	36	42	36
La Scie	-	17	17	18	24	59	42	42	42	42	41	42	42	42	41	42
Shoe Cove	-	18	15	17	30	47	46	42	42	42	41	42	42	42	42	42
Smith's Hr	59	63	60	72	48	58	59	58	60	54	60	60	58	60	60	60
Jackson's Cove	56	48	48	48	32	42	38	40	-	-	-	-	-	-	-	-
Miles Cove	56	67	70	71	48	59	57	50	54	59	60	60	72	66	72	60
Glover's Hr	-	-	-	-	-	54	59	57	58	59	56	54	60	60	57	59
Summerford	60	71	67	69	78	68	60	60	64	76	72	66	66	59	66	59
Durrell	20	11	8	8	22	51	51	56	-	-	-	-	-	-	-	-
Too Good Arm	39	45	44	46	42	66	60	59	60	60	59	53	60	53	60	59
Deep Bay	26	23	24	42	42	-	-	-	-	-	-	-	-	-	-	-
Fogo	-	-	-	-	48	72	60	59	61	59	60	-	-	-	-	-
Fogo	-	-	-	-	-	-	48	46	-	-	-	60	60	60	60	60
Joe Batt's Arm	8	14	4	25	67	72	59	77	-	-	-	-	-	-	-	-
Tilting	12	30	28	30	75	72	60	78	60	63	60	60	60	60	60	59
Seldom	36	39	17	37	68	70	74	69	58	60	53	60	59	60	54	58
Aspen Cove	-	28	27	24	30	35	34	30	23	36	36	36	36	37	36	36
Lumsden	20	47	52	48	42	48	42	36	40	42	36	33	30	39	34	31

NAFO DIV. 3L

Community	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Wesleyville	20	47	53	47	38	42	42	42	42	42	42	-	-	-	-	-
Newtown	-	-	-	-	-	-	-	-	-	-	-	44	-	-	-	-
Greenspond	-	-	-	-	-	-	-	-	-	-	-	-	32	41	47	47
Centreville	40	29	30	32	20	40	40	40	-	-	-	-	-	-	-	-
St. Chad's	60	59	60	58	-	-	-	-	-	-	-	-	-	-	-	-
Happy Adventure	-	-	-	-	59	60	54	60	60	56	60	60	60	49	46	47
Plate Cove West	27	43	44	48	41	58	60	60	60	57	60	54	60	60	60	60
Bonavista	-	39	16	16	30	31	30	30	-	-	-	-	-	-	-	-

Community	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Little Catalina	60	59	51	54	28	40	32	40	40	38	39	36	40	40	38	36
Petley	40	47	48	38	50	68	60	58	53	57	60	58	60	52	52	50
Thornlea	60	71	69	66	48	77	84	60	-	-	-	-	-	-	-	-
Hopeall	40	32	32	32	32	40	40	40	40	40	40	40	40	-	-	-
Hopeall	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Whiteway	-	-	-	-	-	-	-	-	-	-	-	-	-	60	54	-
Heart's Content	-	16	8	36	36	57	40	40	50	50	49	45	40	40	40	40
Bay de Verde	-	28	40	27	40	56	59	57	59	60	57	49	60	46	49	-
Bay de Verde	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	51
Bay de Verde	-															
Ochre Pitt Cove	40	36	44	48	48	60	60	60	-	-	-	-	-	-	-	-
Carbonear	39	48	52	60	40	60	47	48	48	48	48	54	48	54	54	54
Port de Grave	40	-	48	48	48	60	60	55	-	-	-	-	-	-	-	-
Foxtrap	32	37	23	32	28	32	31	32	32	32	28	32	32	32	30	32
Foxtrap	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pouch Cove	39	32	31	43	45	60	60	61	60	60	60	60	60	58	60	60
Petty Hr	-	-	-	-	47	57	45	-	-	-	-	-	-	-	-	-
Petty Hr	-	-	-	-	-	-	-	32	-	-	-	-	-	-	-	-
Bay Bulls	58	8	43	48	32	-	-	-	-	-	-	-	-	-	-	-
Bay Bulls	38	46	47	48	30	48	35	38	26	-	-	-	-	-	-	-
Bay Bulls	-	-	-	-	-	-	-	-	-	60	55	53	60	66	60	60
Calvert	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calvert	-	10	12	12	29	41	40	60	48	60	60	60	60	59	60	60
Ferryland	57	38	34	36	36	56	58	57	-	-	-	-	-	-	-	-
Aquaforte	59	45	48	47	32	48	40	38	-	-	-	-	-	-	-	-
Renews	-	-	25	26	32	47	60	60	59	53	50	59	58	57	58	60
St. Shott's	-	16	38	48	30	38	39	40	36	32	40	40	-	-	-	-
Riverhead	28	54	43	36	38	34	40	36	28	34	32	14	32	32	40	28

Community	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Riverhead	-	10	17	36	25	38	29	42	-	-	-	-	-	-	-	-
Admiral's Beach	61	48	44	48	32	38	39	40	40	35	37	39	40	37	40	40
Point Lance	-	-	-	-	-	30	31	41	20	28	28	28	28	32	28	28
Point Lance	58	48	48	48	6	-	-	-	-	-	-	-	-	-	-	-

Table 2. Number of Sentinel sets (3¼" gillnet) by community since 1995.

NAFO DIV. 2J

Community	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Black Tickle	-	-	11	14	16	-	20	18	18	20	20	17	20	19	20	18
Williams Hr	-	-	9	10	8	9	10	9	-	10	-	-	-	-	-	-
Tub Hr	-	1	4	4	9	20	20	20	-	-	-	-	-	-	-	-
Triangle	-	-	6	7	15	12	20	20	20	20	20	20	20	20	20	10
Penny's Hr	-	1	3	15	16	21	20	14	20	20	17	20	20	20	20	20
Spear Hr	-	1	6	22	16	20	20	22	20	20	20	20	20	20	-	-
St. Lewis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20	20
Mary's Hr	-	-	9	9	14	20	20	20	20	21	20	20	20	20	16	20
Cape Charles	-	-	-	-	-	17	20	20	20	20	20	18	20	20	20	19

NAFO DIV. 3K

Community	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	201
Quirpon	-	-	-	-	-	-	16	-	-	-	-	-	-	-	-	-
St. Lunaire	-	1	-	9	4	-	10	15	15	17	10	9	4	-	-	-
Great Brehat	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-
Goose Cove	-	-	-	-	-	-	-	8	20	20	20	14	10	10	10	10
Englee	-	-	-	9	7	7	10	10	10	10	10	-	-	-	-	-
Englee	-	-	-	-	-	-	-	-	-	-	-	6	9	10	8	-
Hr Deep	-	-	6	7	8	10	11	10	10	10	-	-	-	-	-	-
Jackson's Arm	-	-	4	12	8	-	-	-	-	-	-	-	-	-	-	-
Sopp's Arm	-	-	-	-	-	-	-	10	10	10	10	10	8	10	10	10
Westport	-	-	-	-	-	-	9	9	-	-	-	-	-	-	-	-
Coachman's Cove	-	-	4	7	9	10	10	10	10	10	10	10	10	10	10	10
La Scie	-	-	1	3	4	11	7	5	4	7	7	7	7	7	7	7
Miles Cove	-	8	11	12	8	10	11	9	10	10	10	9	12	9	11	10
Glover's Hr	-	-	-	-	-	-	10	8	9	10	9	9	9	10	9	9
Summerford	-	6	9	12	13	11	11	10	11	14	12	11	11	10	11	10
Too Good Arm	-	-	7	8	6	11	10	9	10	10	10	9	10	10	10	10
Deep Bay	-	-	-	7	7	-	-	-	-	-	-	-	-	-	-	-
Fogo	-	-	-	-	-	-	-	5	10	10	10	-	-	-	-	-
Joe Batt's Arm	-	-	-	4	11	5	11	9	-	-	-	-	-	-	-	-
Tilting	-	-	-	5	7	6	9	5	4	9	7	4	4	7	4	4
Seldom	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-

NAFO DIV. 3L

Community	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	201
Wesleyville	-	-	12	15	12	14	13	14	14	14	14	-	-	-	-	-
Newtown	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-
Greenspond	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	8
Happy Adventure	-	-	-	-	-	10	9	10	10	9	10	10	9	9	10	10

Community	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	201
Plate Cove West	-	-	4	8	7	10	10	10	10	9	10	8	10	10	10	10
Little Catalina	-	-	13	20	8	19	12	20	20	19	20	18	20	20	19	18
Petley	-	4	8	8	9	12	11	10	10	10	10	10	10	10	10	10
Hopeall	-	-	-	-	-	-	10	10	10	9	10	10	10	-	-	-
Heart's Content	-	-	4	12	12	18	8	8	10	10	10	9	10	10	10	10
Bay de Verde	-	-	2	4	6	8	8	9	9	10	8	7	9	7	8	-
Foxtrap	-	1	7	8	7	8	7	8	8	8	7	8	8	8	8	8
Foxtrap	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pouch Cove	-	-	3	8	8	10	10	9	10	10	10	10	10	10	10	10
Bay Bulls	-	-	6	12	8	-	-	-	-	-	-	-	-	-	-	-
Bay Bulls	-	-	-	-	-	-	7	7	6	-	-	-	-	-	-	-
Bay Bulls	-	-	-	-	-	-	-	-	-	-	1	-	1	2	2	7
Ferryland	-	2	5	3	3	5	7	8	-	-	-	-	-	-	-	-
Renews	-	-	-	-	-	-	-	-	10	-	4	10	10	9	10	10
St. Shott's	-	-	5	3	-	7	-	-	-	-	-	-	-	-	-	-
Admiral's Beach	-	2	15	24	15	19	20	20	20	18	19	20	20	21	20	20

Table 3. Number of Sentinel sets (linetrawl) by community since 1995.

NAFO DIV. 2J

Community	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	201
Black Tickle	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-
Williams Hr	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-
Tub Hr	-	12	12	8	3	-	4	-	-	-	-	-	-	-	-	-
Triangle	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-
Penny's Hr	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-
Cape Charles	-	8	10	-	-	-	-	-	-	-	-	-	-	-	-	-

NAFO DIV. 3K

Community	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	201

Community	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Goose Cove	60	32	14	16	8	14	8	6	-	-	-	-	-	-	-	-
Englee	-	-	-	-	-	-	-	-	-	-	-	-	8	2	-	-
Sopp's Arm	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Coachman's Cove	26	32	4	5	5	8	5	5	4	3	6	2	4	4	4	4
Ming's Bight	56	45	45	30	12	23	24	24	20	16	16	12	10	16	12	16
La Scie	36	27	30	28	10	-	18	18	12	12	12	12	12	12	11	12
Shoe Cove	60	35	36	36	22	8	16	18	12	12	12	12	12	12	12	12
Durrell	35	48	30	30	14	6	4	3	-	-	-	-	-	-	-	-
Deep Bay	18	17	21	-	-	-	-	-	-	-	-	-	-	-	-	-
Fogo	-	-	-	-	16	-	-	-	-	-	-	-	-	-	-	-
Joe Batt's Arm	40	14	22	12	-	-	-	-	-	-	-	-	-	-	-	-
Tilting	41	10	15	4	-	-	-	-	1	-	-	-	-	-	-	-
Seldom	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-
Aspen Cove	39	12	16	8	17	24	24	25	23	25	23	24	23	8	24	21
Lumsden	54	24	22	15	12	8	12	16	12	11	14	13	16	12	16	13

NAFO DIV. 3L

Community	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Wesleyville	44	20	11	16	12	12	12	12	11	11	12	-	-	-	-	-
Newtown	-	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-
Greenspond	-	-	-	-	-	-	-	-	-	-	-	-	2	4	4	4
Happy Adventure	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-
Bonavista	-	1	10	4	-	1	3	8	-	-	-	-	-	-	-	-
Petley	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Heart's Content	57	-	24	18	-	-	11	12	-	-	-	-	-	-	-	-
Carbonear	15	22	19	11	6	-	12	12	8	8	8	4	8	4	4	4
Foxtrap	42	24	24	24	6	6	12	12	8	8	12	8	8	8	8	8
Foxtrap	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bay Bulls	17	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-

Community	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Bay Bulls	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-
Calvert	60	33	33	40	17	23	18	-	8	-	-	-	-	-	-	-
Aquaforte	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Renews	7	37	-	-	-	-	-	-	-	-	-	-	-	-	-	-
St. Shott's	33	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Riverhead	40	13	15	16	6	8	4	6	8	8	8	6	16	8	-	8
Riverhead	50	28	13	-	-	2	18	-	-	-	-	-	-	-	-	-
Point Lance	-	-	-	-	-	-	4	-	16	12	11	12	12	8	12	12

FIGURES

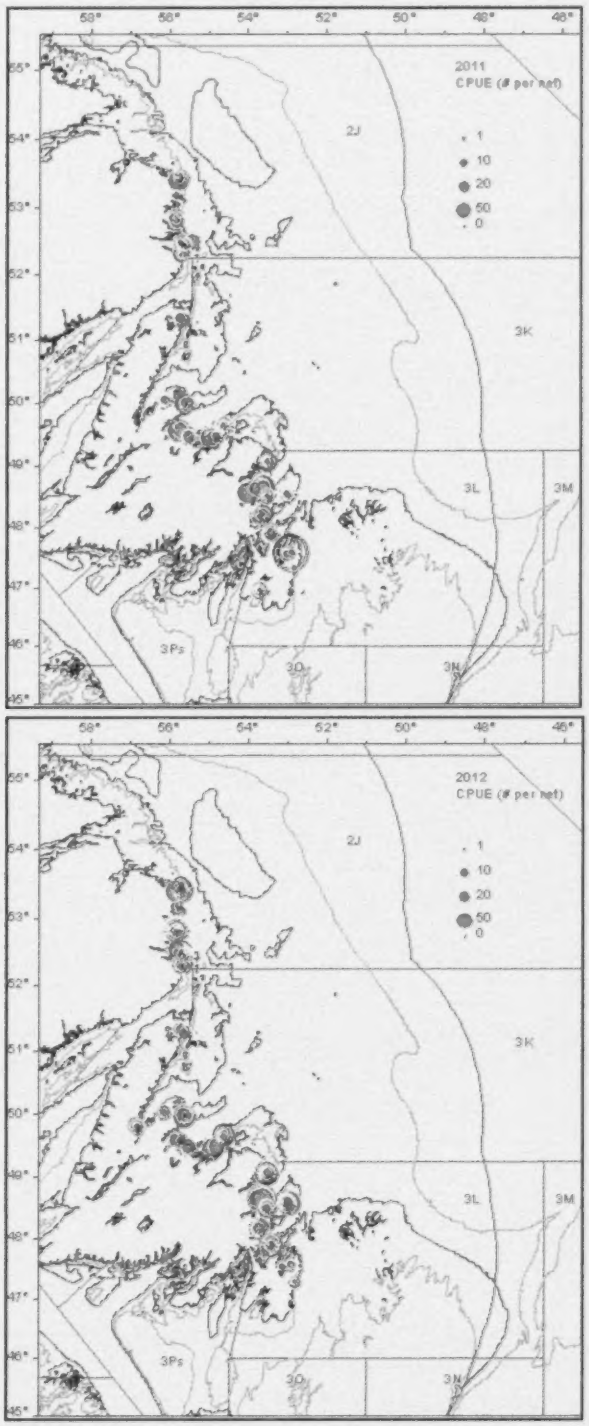


Figure 1. Expanding symbol plot of CPUE (number of Cod per net) for 5 ½ inch gillnet in 2011 and 2012.

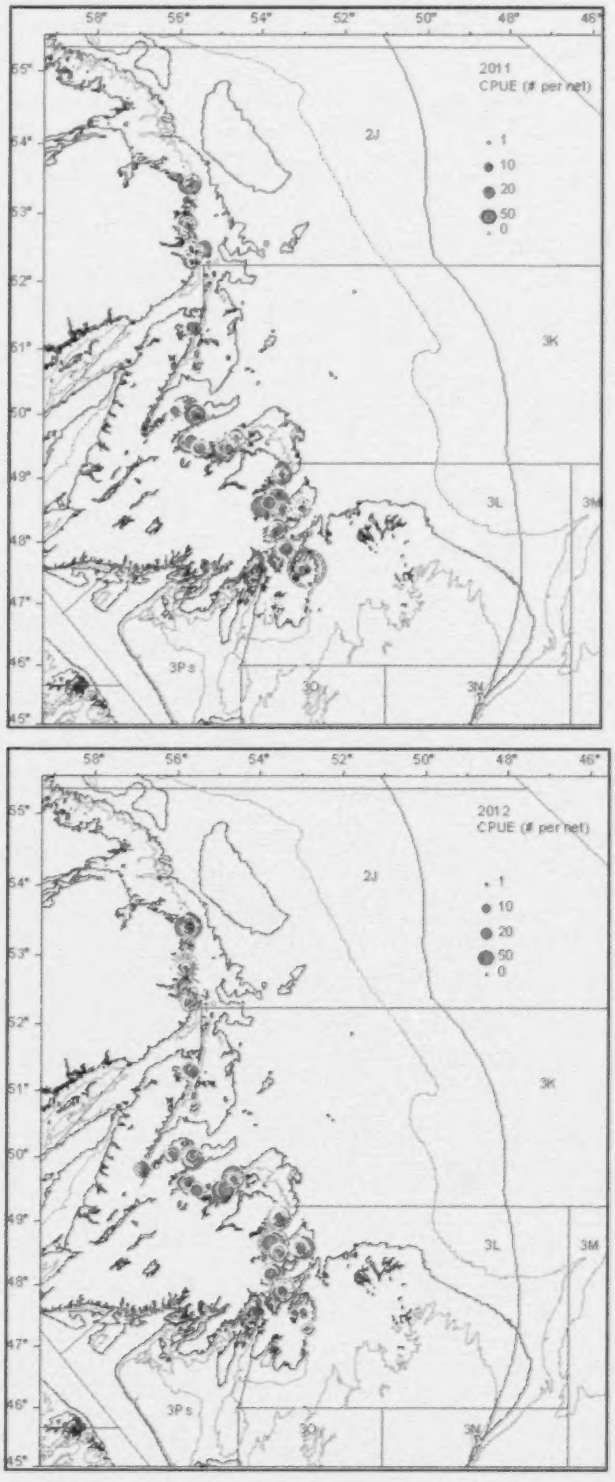


Figure 2. Expanding symbol plot of CPUE (number of Cod per net) for 3 ¼" gillnet in 2011 and 2012.

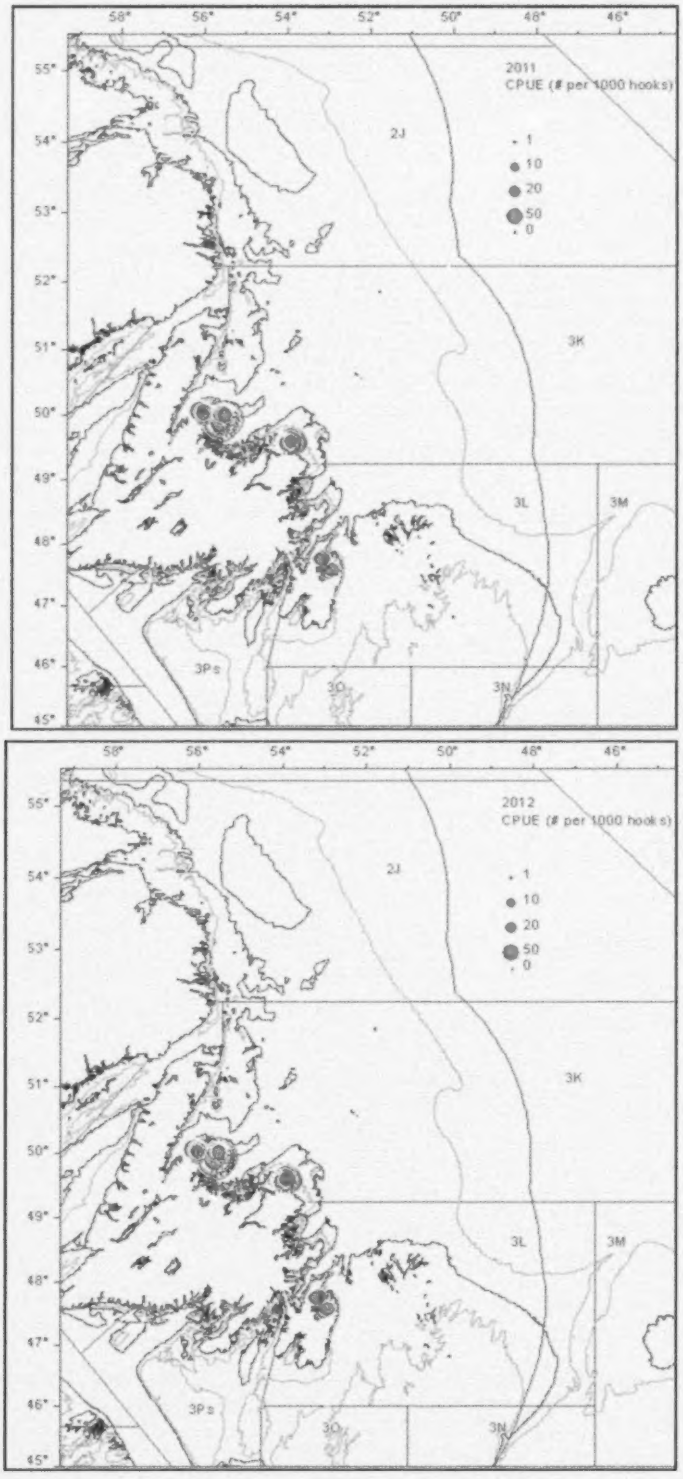
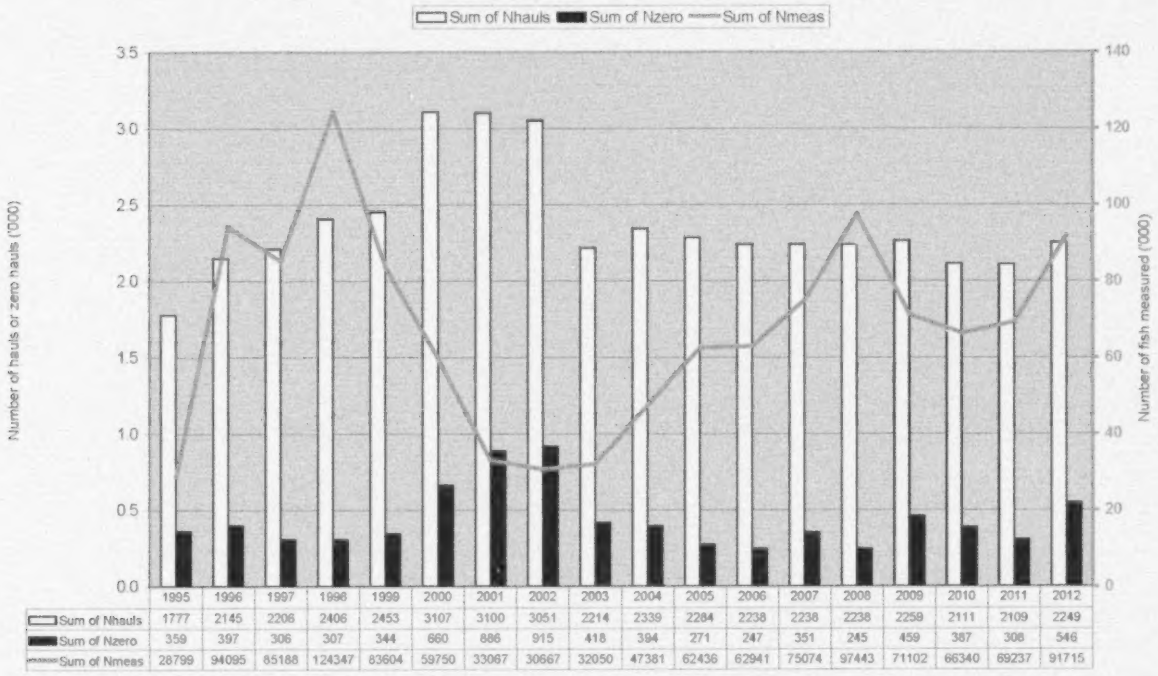
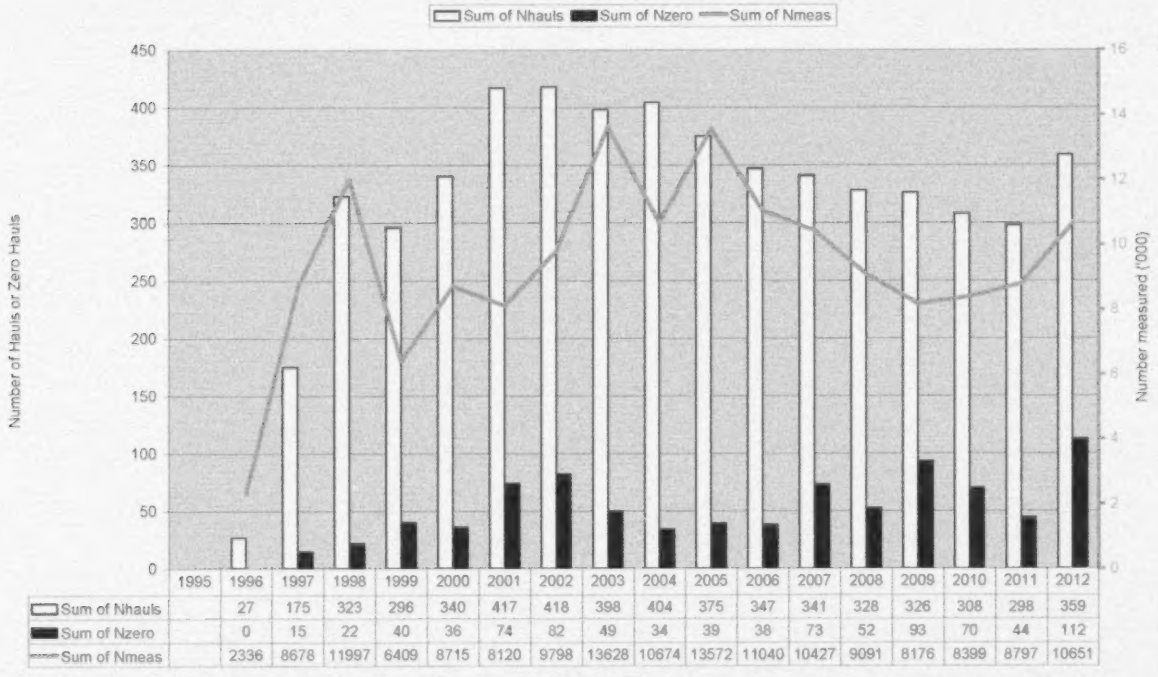


Figure 3. Expanding symbol plot of CPUE (number of Cod per 1000 hooks) for linetrawl in 2011 and 2012.



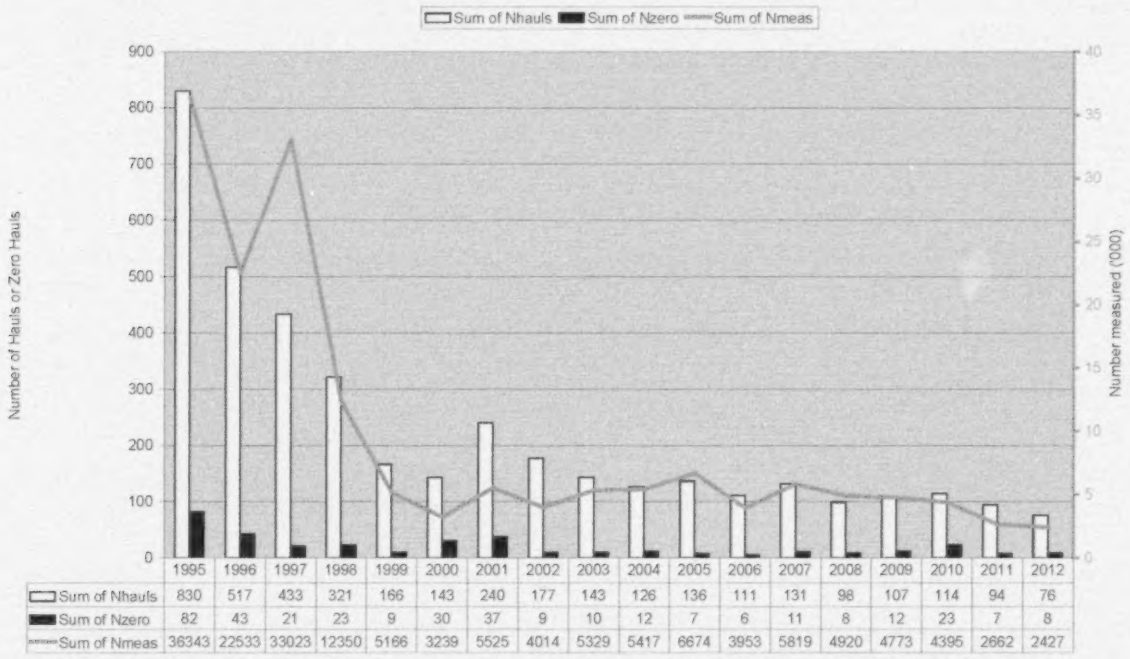
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Sum of Nhauls	1777	2145	2206	2406	2453	3107	3100	3051	2214	2339	2284	2238	2238	2238	2259	2111	2109	2249
Sum of Nzero	359	397	306	307	344	660	886	915	418	394	271	247	351	245	459	387	308	546
Sum of Nmeas	28799	94095	85188	124347	83604	59750	33067	30667	32050	47381	62436	62941	75074	97443	71102	66340	69237	91715

Figure 4. Summary data for 5 ½" gillnet in NAFO Div. 2J3KL (Nhauls= number of sets, NZero=number of hauls with no Cod, Nmeas=number of Cod caught)



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Sum of Nhauls		27	175	323	296	340	417	418	398	404	375	347	341	328	326	308	298	359
Sum of Nzero		0	15	22	40	36	74	82	49	34	39	38	73	52	93	70	44	112
Sum of Nmeas		2336	8678	11997	6409	8715	8120	9798	13628	10674	13572	11040	10427	9091	8176	8399	8797	10651

Figure 5. Summary data for 3 ¼" gillnet in NAFO Div. 2J3KL (Nhauls= number of sets, NZero=number of hauls with no Cod, Nmeas=number of Cod caught)



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Sum of Nhauls	830	517	433	321	166	143	240	177	143	126	136	111	131	98	107	114	94	76
Sum of Nzero	82	43	21	23	9	30	37	9	10	12	7	6	11	8	12	23	7	8
Sum of Nmeas	36343	22533	33023	12350	5166	3239	5525	4014	5329	5417	6674	3953	5819	4920	4773	4395	2662	2427

Figure 6. Summary data for linetrawl in NAFO Div. 2J3KL (Nhauls= number of sets, NZero=number of hauls with no Cod, Nmeas=number of Cod caught).

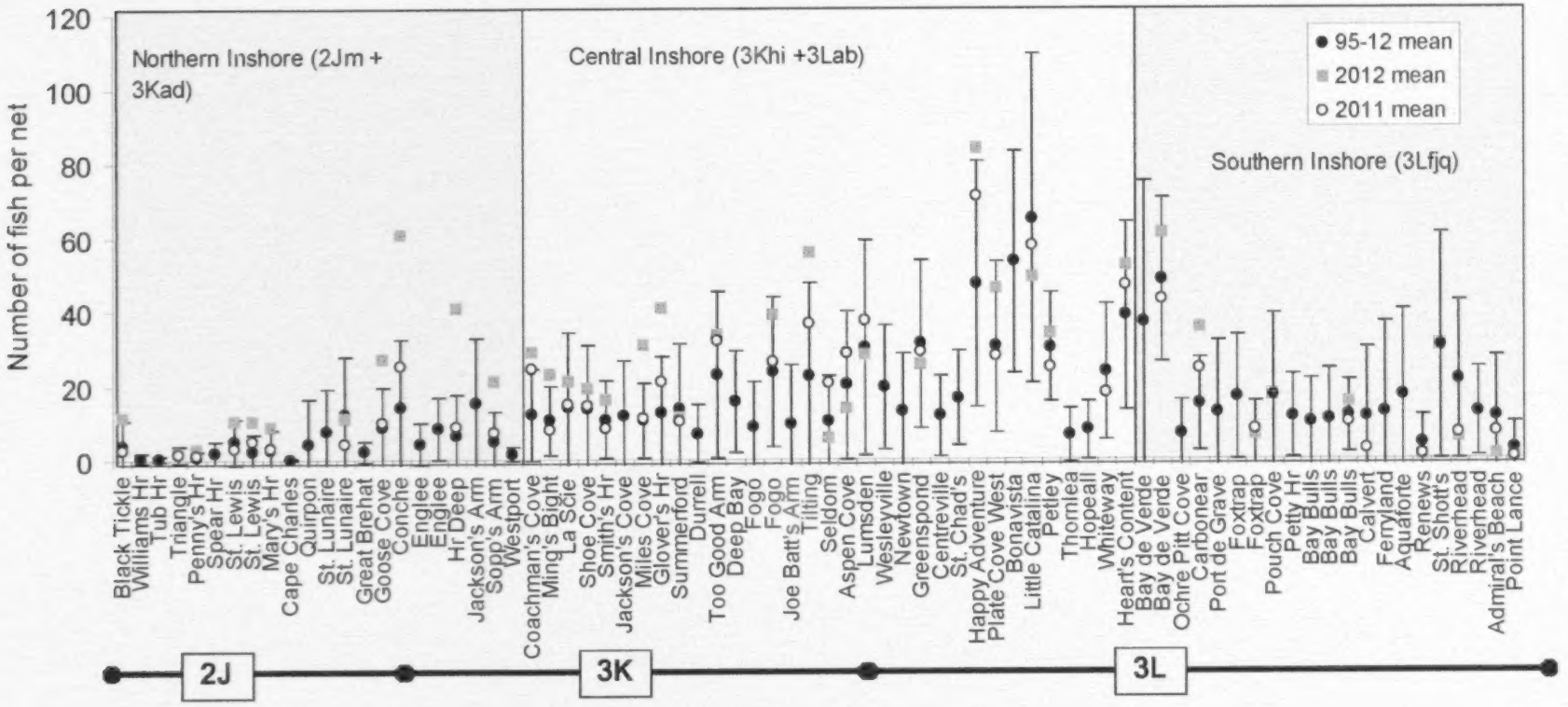


Figure 7. Mean catch per unit effort by community (number of Cod per net) for 5 ½" gillnet; mean ± 1 SD (1995-2012) and mean CPUE for 2011 and 2012.

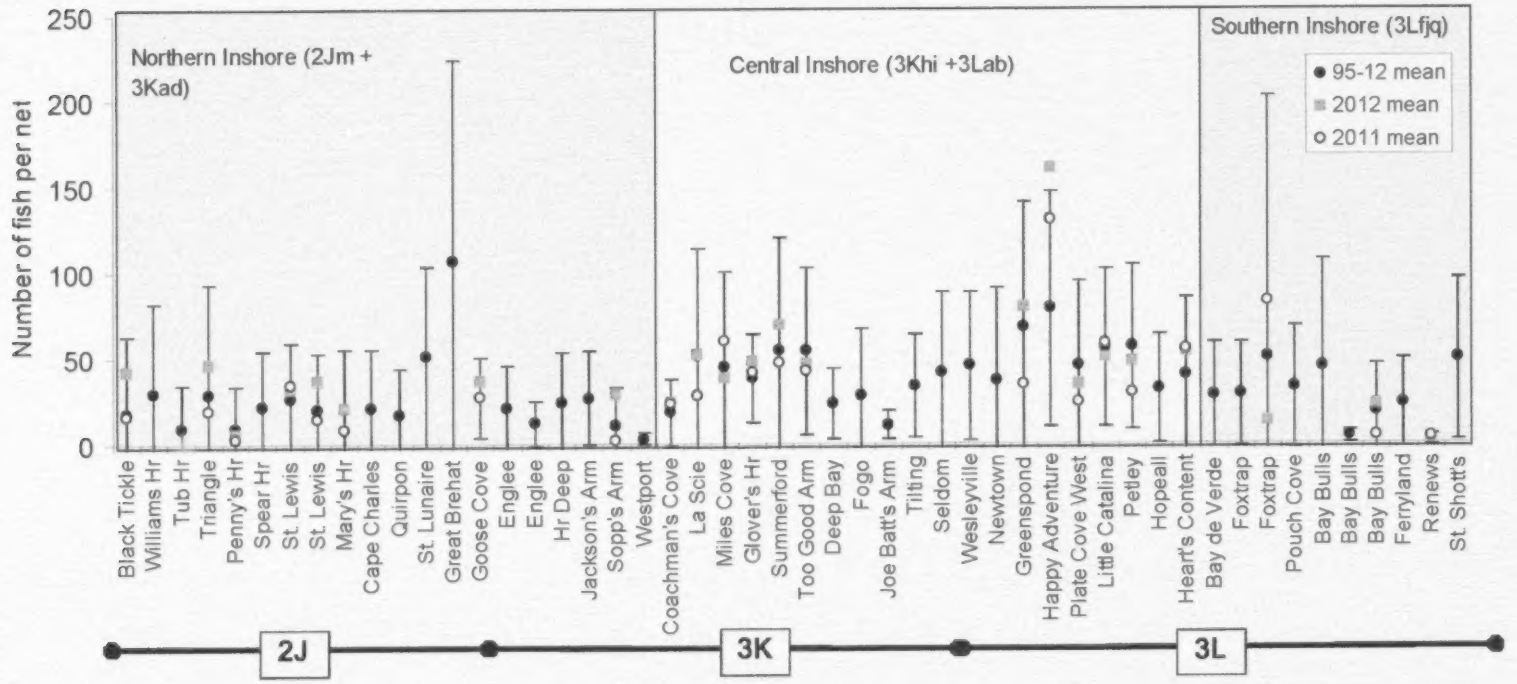


Figure 8. Mean catch per unit effort by community (number of Cod per net) for 3 ¼" gillnet; mean ± 1 SD (1995-2012) and mean CPUE for 2011 and 2012.

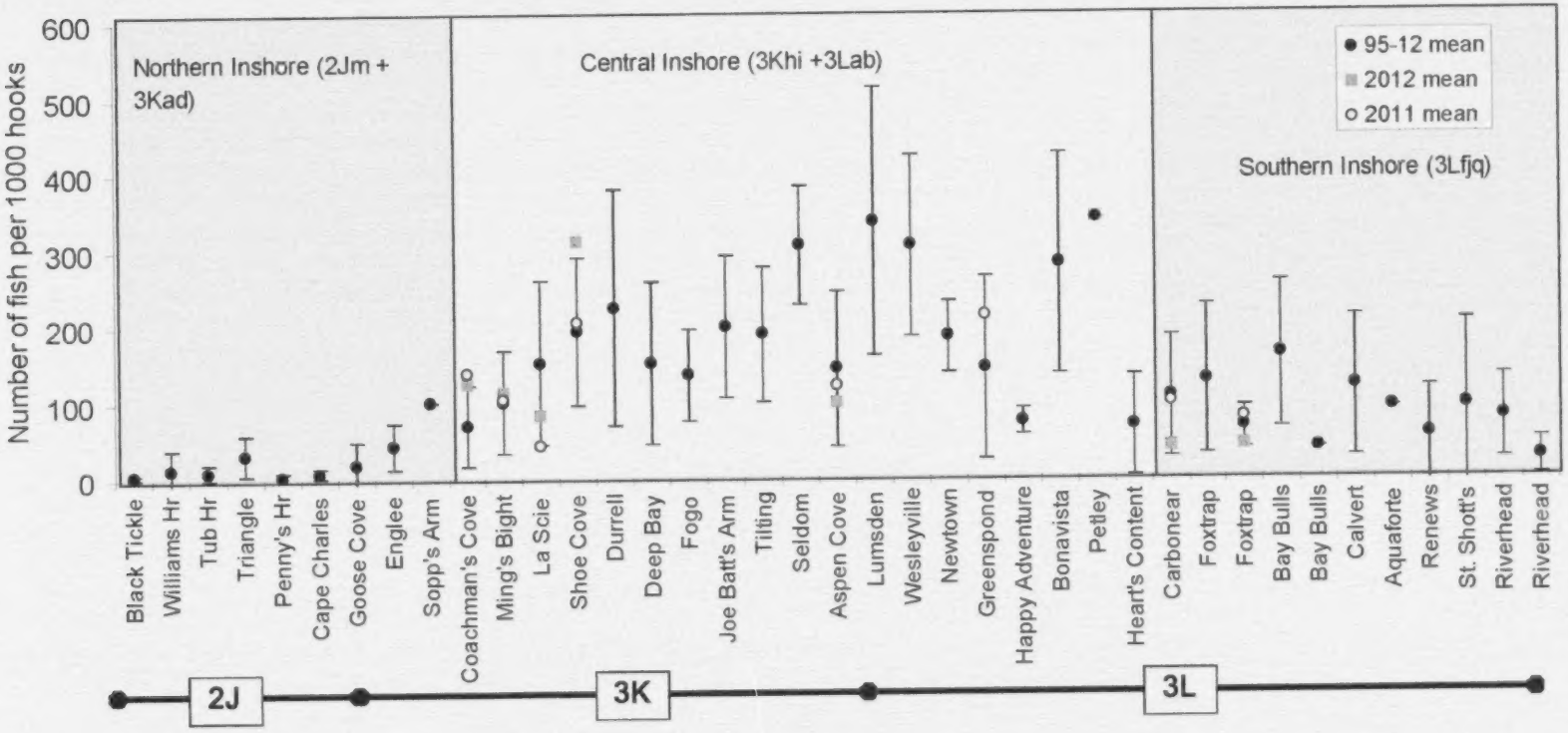


Figure 9. Mean catch per unit effort by community (number of Cod per net) for linetrawl; mean ± 1 SD (1995-2012) and mean CPUE for 2011 and 2012.

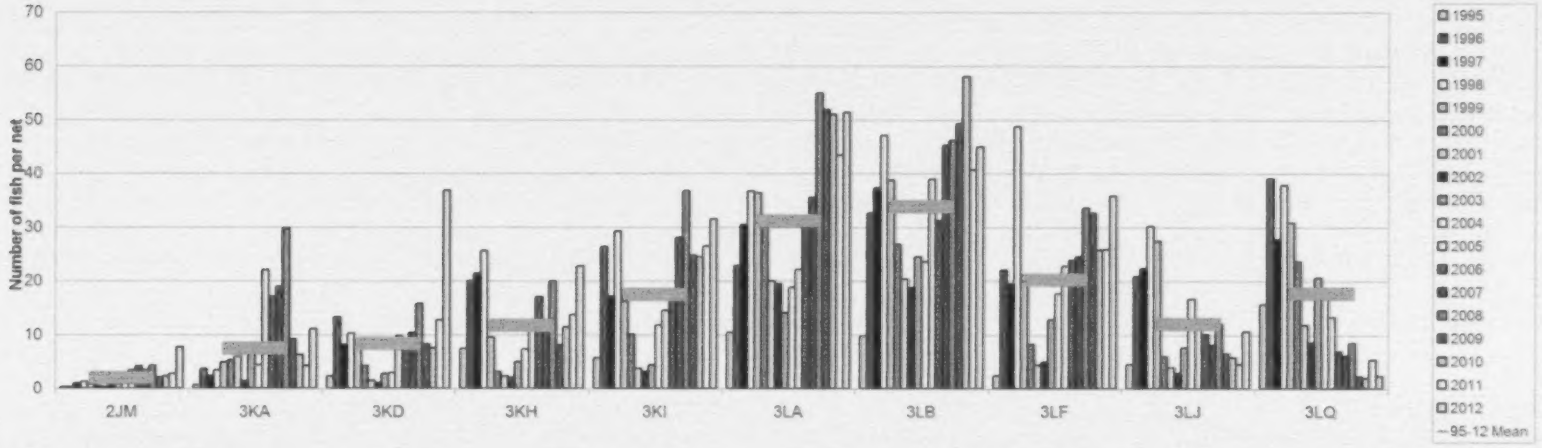


Figure 10. Mean catch per unit effort by NAFO unit area (number of Cod per net) for 5 ½" gillnet; annual means shown for 1995-2012 and series mean (1995-2012; horizontal bar).

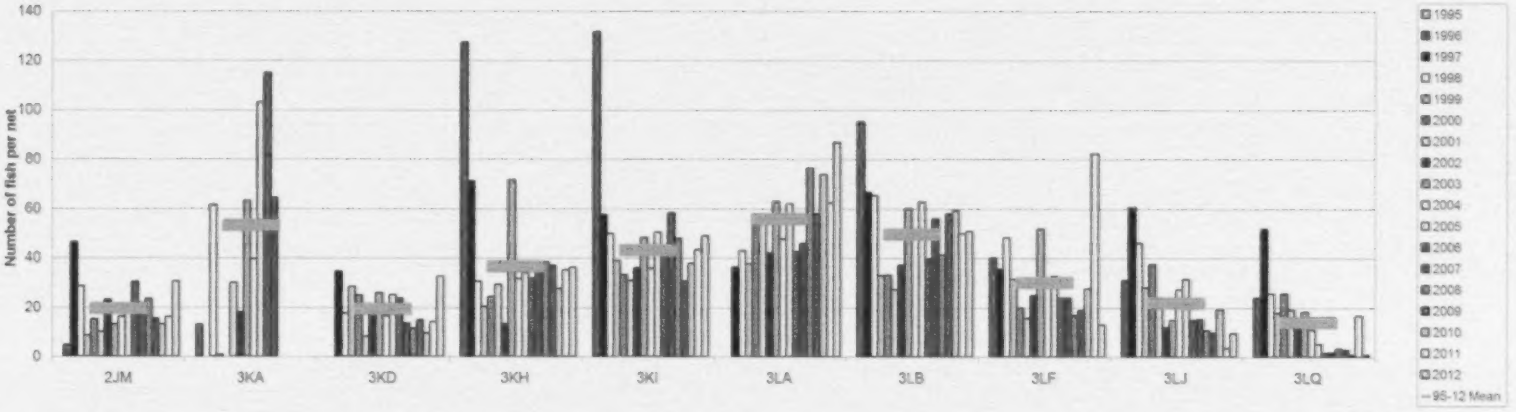


Figure 11. Mean catch per unit effort by NAFO unit area (number of Cod per net) for 3 ¼" gillnet; annual means shown for 1995-2012 and series mean (1995-2012; horizontal bar).

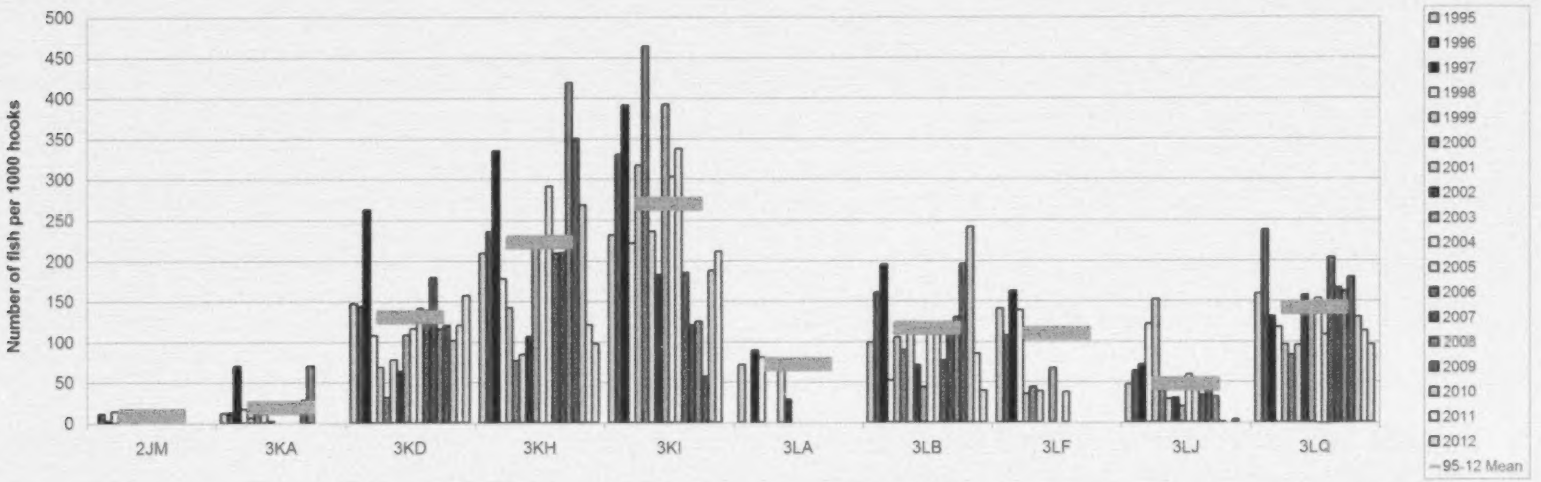


Figure 12. Mean catch per unit effort by NAFO unit area (number of Cod per net) for linetrawl; annual means shown for 1995-2012 and series mean (1995-2012; horizontal bar).

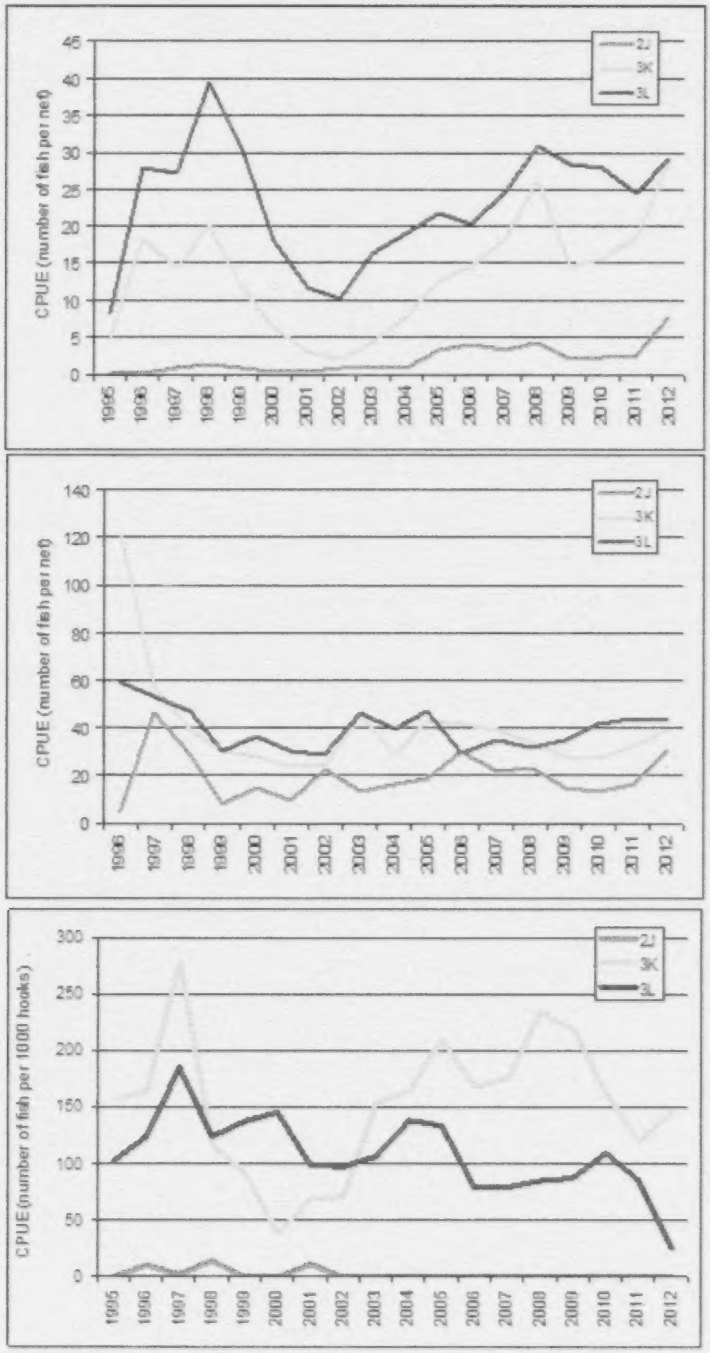


Figure 13. Mean catch per unit effort (number ofCod per net or 1000 hooks) by NAFO Division for 5½ inch gillnet (top panel), 3 ¼" gillnet (middle panel) and linetrawl (lower panel).

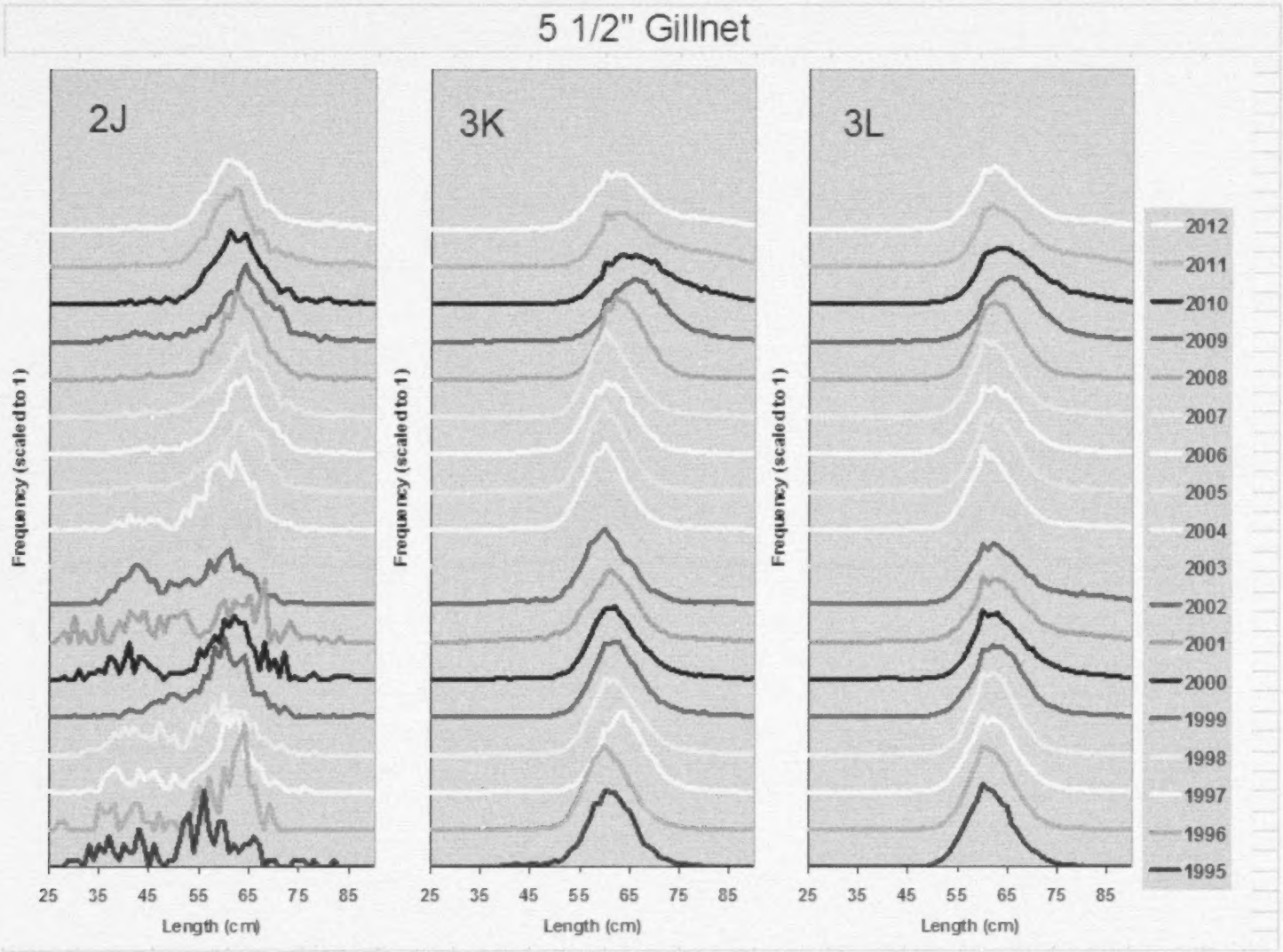


Figure 14. Length frequencies of Cod (scaled to 1) measured from 5 ½" gillnet in NAFO Divisions 2J3KL from 1995 to 2012.

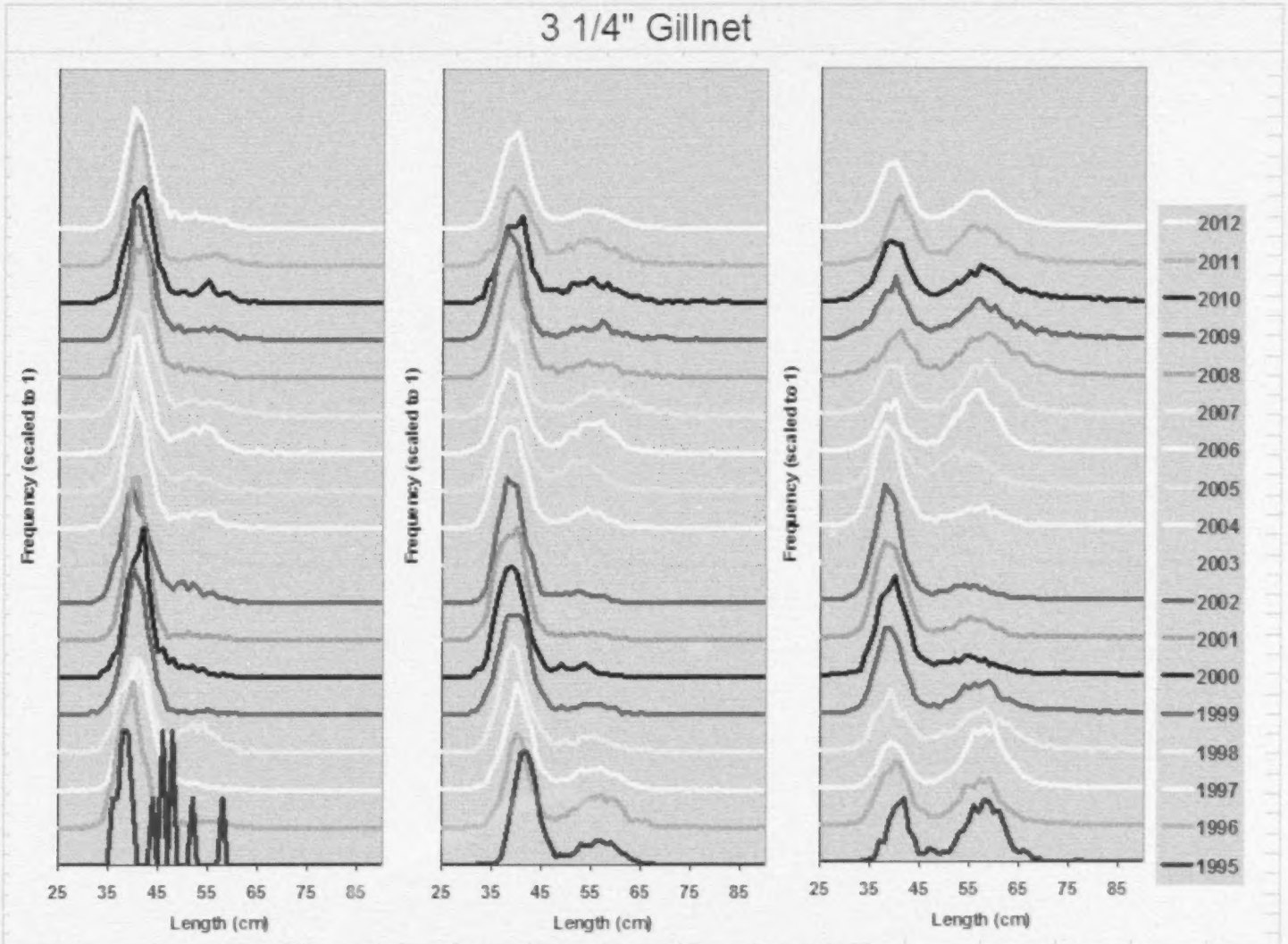


Figure 15. Length frequencies of Cod (scaled to 1) measured from 3 ¼" gillnet in NAFO Divisions 2J3KL from 1996 to 2012.

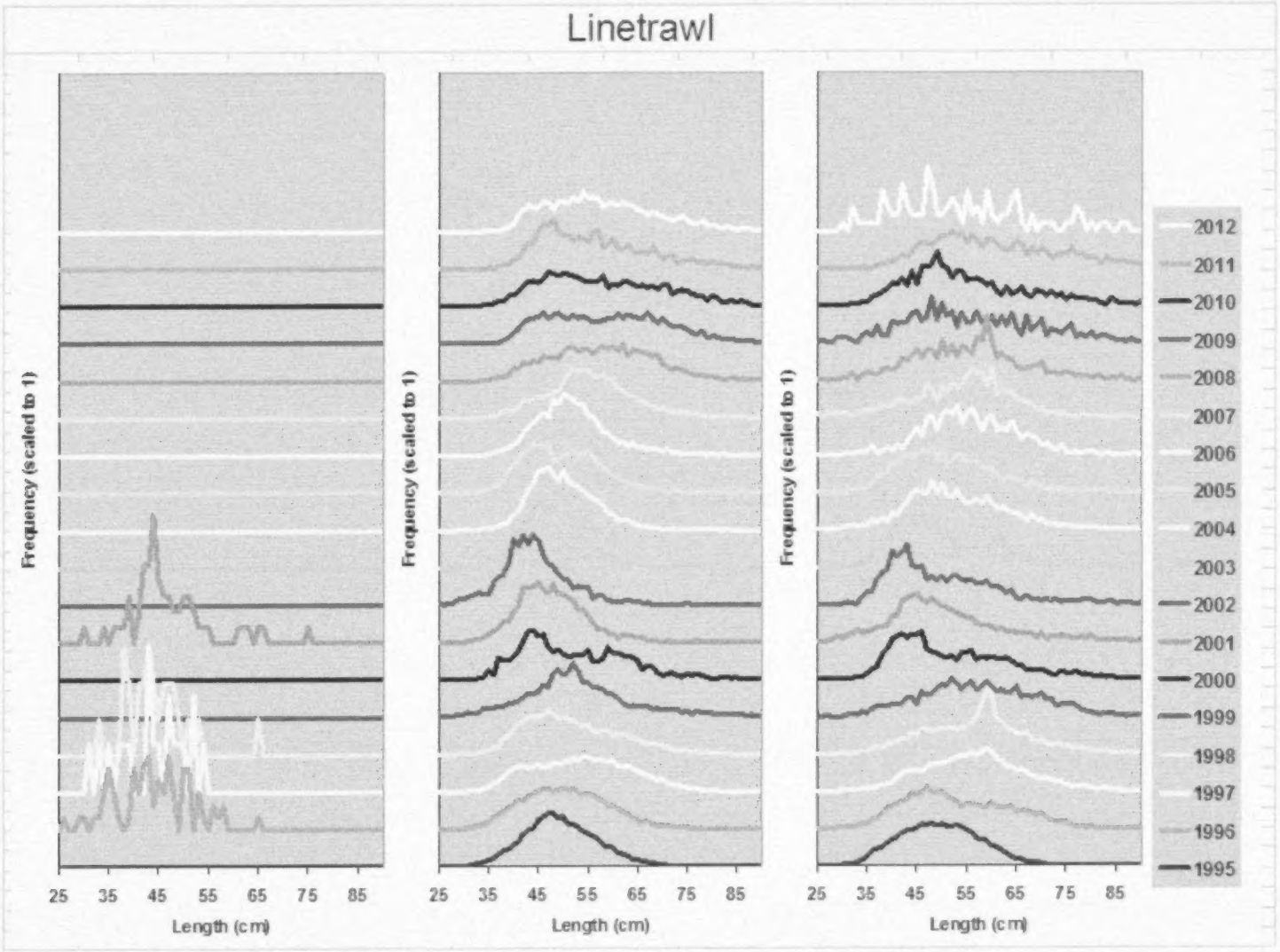


Figure 16. Length frequencies of Cod (scaled to 1) measured from linetrawl in NAFO Divisions 2J3KL from 1996 to 2012.

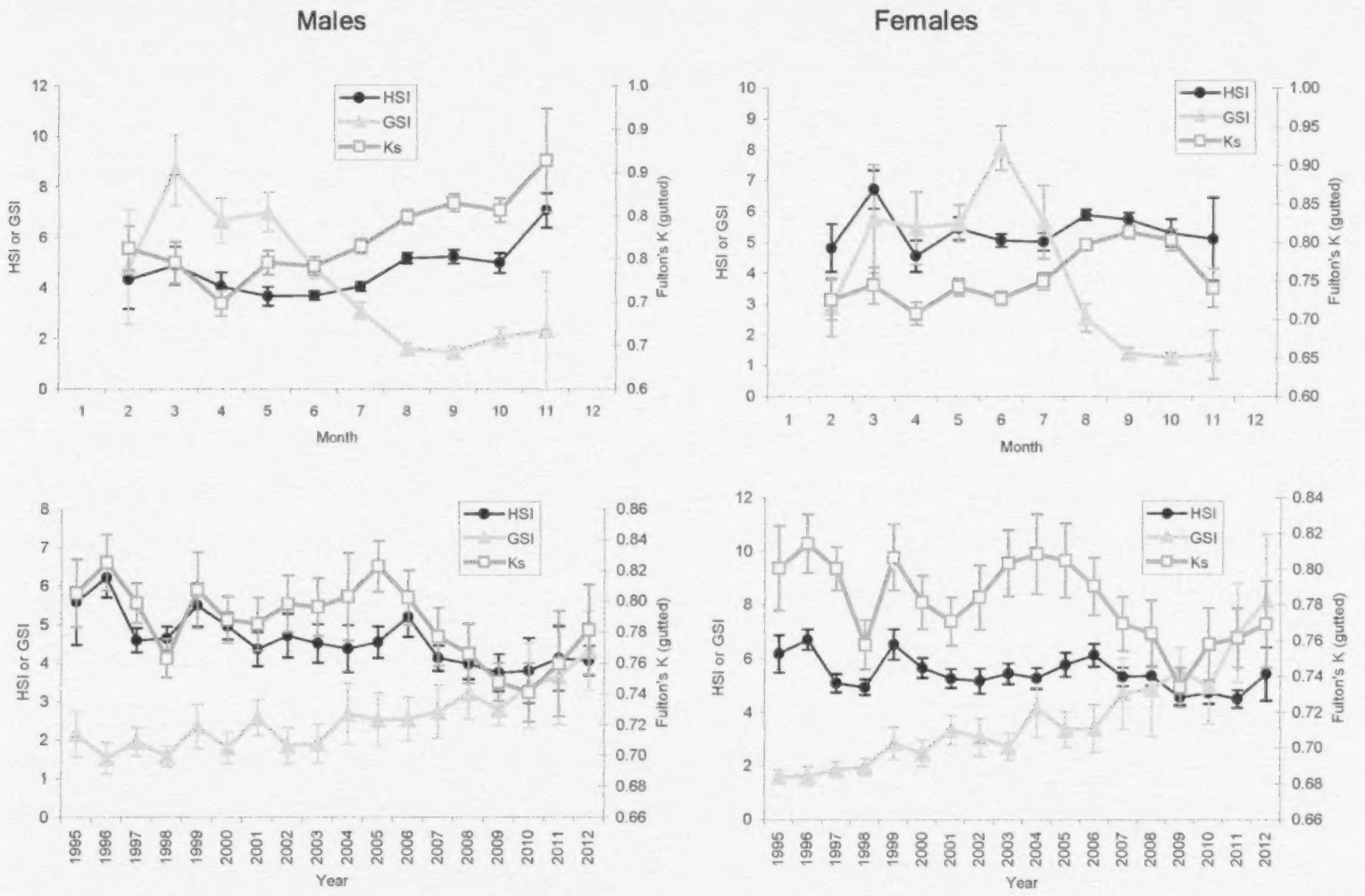


Figure 17. Gonadosomatic index (GSI), hepatosomatic index (HSI)and Fulton's condition factor (Ks) by month (top panels) and year (lower panels) for male and female Cod sampled in Sentinel surveys in NAFO Div. 2J3KL. Data plotted are mean ± 2 SE.

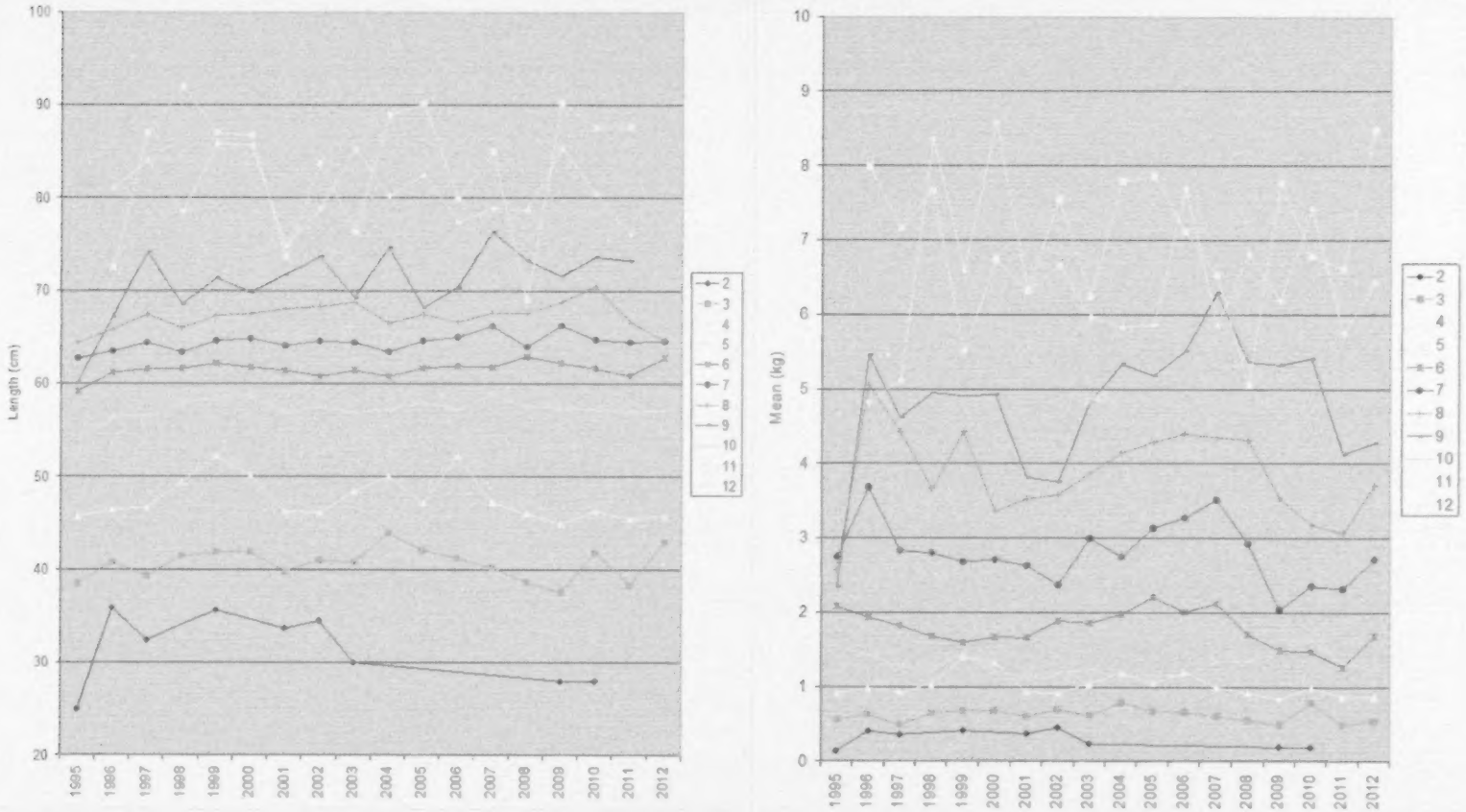


Figure 18. Bias-corrected mean length (cm;left panel) and weight (kg; right panel) at age of Cod from Sentinel surveys in NAFO Div. 2J3KL from 1995 to 2012.

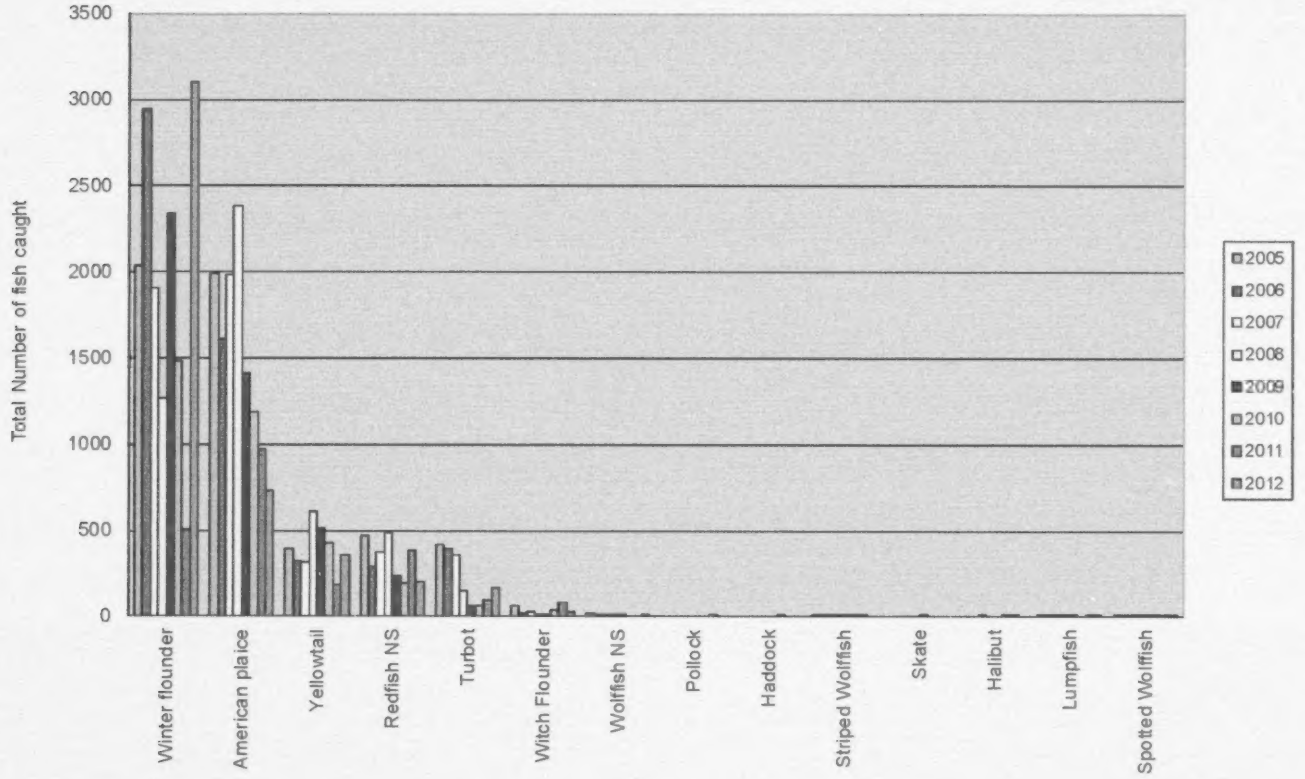


Figure 19. By-catch of species other than Cod in Sentinel gillnet and linetrawl from 2005-2012.